Customer No. :31561
Application No: 10/604,763
Docket NO.:11286-US-PA

Claim Amendment

Please amend the claims according to the following listing of claims and substitute it for all prior versions and listings of claims in the application.

1. (original) A fabrication method for a memory device that comprises a deep trench, the method comprising:

providing a substrate;

forming a plurality of deep trenches in the substrate, wherein the deep trenches are rectangular shape when viewing from a top, and each trench comprises a first short side and a second short side, and between the first short side and the second short side of any two corresponding deep trenches is a pre-defined region for an active region;

forming a doped region in the substrate around a lower part and a bottom part of each deep trench;

forming a conformal dielectric layer on a bottom part and a sidewall of the lower part of each deep trench;

forming a first conductive layer in the bottom part and the lower part of the deep trench, encompassed by the first dielectric layer;

forming a collar oxide layer at a periphery of a middle part of each deep trench;

forming a second conductive layer in each deep trench, encompassed by the collar oxide layer;

forming an undoped semiconductor layer in the upper part of each deep trench;

implanting dopants into the undoped semiconductor layer, except at the periphery of the first short side and the second short side of each deep trench, to form a third conductive layer;

removing a portion of the third conductive layer, a portion of the collar oxide layer and a portion of the substrate inside the deep trenches to form a plurality of shallow trenches in the substrate; and

filling in an insulation layer in each of the shallow trenches to form a plurality of isolation structures and to define a plurality of active regions in the pre-defined region for the active region.

2. (original) The method of claim 1, wherein forming the deep trenches in the substrate comprises:

forming a patterned first mask layer on the substrate, wherein the patterned first mask layer comprises a plurality of first openings; and

transferring the first opening pattern of the first mask layer to the substrate to form the deep trenches in the substrate.

3. (original) The method of claim 1, wherein implanting dopants into the undoped semiconductor layer, except at the periphery of the first short side and the second short side of each deep trench further comprises:

forming a second mask layer on the first mask layer, wherein the second mask layer covers the periphery of the first short side and the second short side of the deep trenches;

performing an ion implantation process to implant dopants into the undoped semiconductor layer to form the third conductive layer, using the second mask layer and the first mask layer as an implantation mask; and

removing the first mask layer and the second mask layer.

4. (original) The method of claim 3, wherein forming the second mask layer further comprises:

forming an anti-reflection layer on the substrate;

forming a patterned photoresist layer on the anti-reflection layer, wherein the patterned photoresist layer exposes a portion of the anti-reflection layer in the deep trenches; and

removing the anti-reflection the is not covered by the patterned photoresist layer to expose a portion of the undoped semiconductor layer.

5. (original) The method of claim 3, wherein the deep trenches comprise neighboring a first column of a plurality of trenches and a second column of a plurality of trenches, and the second mask comprises a first long stripe mask and a second long stripe mask, and the first long stripe mask covers the undoped semiconductor layer at the periphery of the first short side of the deep trenches of the first column and the undoped semiconductor layer at the periphery

of the second short side of the deep trenches of the second column, and the second long stripe mask covers the undoped semiconductor layer at the periphery of the second short side of the deep trenches of the first column and the undoped semiconductor layer at the periphery of the first short side of the deep trenches of the neighboring second column.

6. (original) The method of claim 2, wherein forming the undoped semiconductor layer in the upper part of each deep trench further comprises:

forming an undoped semiconductor material layer on the substrate, wherein the undoped semiconductor material layer fills the deep trenches and covers the first mask layer; and

performing a removing process to remove the undoped semiconductor material layer on the first mask layer and a portion of the undoped semiconductor material layer in the deep trenches.

7. (previously presented) The method of claim 6, wherein removing the portion of the undoped semiconductor material layer further comprises:

performing a chemical mechanical polishing process to remove the undoped semiconductor material layer that covers the first mask layer; and

performing an etching-back process to remove the undoped semiconductor material layer in the deep trenches.

8. (original) The method of claim 2, wherein forming the shallow trenches in the substrate comprises:

forming a third mask layer on the substrate, wherein the third mask layer comprises a second opening that exposes a portion of the third conductive layer, a portion of the collar layer and a portion of the first mask layer in the deep trenches; and

removing the portion of the third conductive layer, the portion of the collar layer and the portion of the first mask layer in the deep trenches exposed by the second opening to form the shallow trenches in the substrate.

9. (original) The method of claim 1, wherein the method further comprises:

forming a gate dielectric layer on each active region;

forming two patterned gate conductive layers on each gate dielectric layer; and

forming a plurality of source/drain regions in the substrate beside two sides of the patterned gate conductive layer.

10. (previously presented) A fabrication method for a memory device that comprises a deep trench capacitor, the fabrication method comprising:

providing a substrate;

forming a plurality of deep trenches in the substrate, wherein the deep trenches is differentiated into a plurality of a first column of the deep trenches and a plurality of a second column of the deep trenches, and the first column of the deep trenches and the second column of the deep trenches are arranged alternately;

forming a doped region in the substrate, around a lower part and a bottom part of each deep trench;

forming a conformal dielectric layer on the bottom part and a sidewall of the lower part of each deep trench;

forming a first conductive layer in the lower part and the bottom part of each deep trench, encompassed by the dielectric layer;

forming a collar oxide layer at a periphery of a middle part of each deep trench;

forming a second conductive layer in each trench, encompassed by the collar oxide layer;

forming an undoped semiconductor layer in an upper part of each trench;

implanting dopants into a part of the undoped semiconductor layer; and

defining a plurality of active regions in the substrate, wherein the active region extends from one deep trench to a neighboring deep trench along a same column, wherein the one deep trench and the neighboring deep trench are at a greater distance apart, wherein a border of the deep trench that is adjacent to the neighboring active region is a first region, and during the

implantation of the dopants into the undoped semiconductor layer, the undoped semiconductor layer of the first region is not doped with the dopants.

11. (original) The method of claim 10, wherein forming the deep trenches in the substrate further comprises:

forming a patterned first mask layer on the substrate, wherein the patterned mask layer comprises a plurality of first openings; and

transferring the first opening pattern of the first mask layer to the substrate to form the deep trenches in the substrate.

12. (original) The method of claim 11, wherein the step of implanting the dopants into the part of the undoped semiconductor layer comprises:

forming a second mask layer on the first mask layer, and the second mask layer covers the undoped semiconductor layer of the first region;

performing an ion implantation process to implant dopants into the undoped semiconductor layer outside the first region to form a third conductive layer in each of the trenches using the second mask layer and the first mask layer as an implantation mask; and

removing the first mask layer and the second mask layer.

13. (original) The method of claim 12, wherein the step of forming the second mask layer comprises:

forming an anti-reflection layer on the substrate; and

forming a patterned photoresist layer on the anti-reflection layer, wherein the patterned photoresist layer exposes a portion of the undoped semiconductor layer.

14. (original) The method of claim 12, wherein the second mask is a mask with a plural of long stripes which cover the undoped semiconductor layer of the neighboring first region between the deep trenches of any two neighboring deep trenches of the first column and of the second column.

15. (original) The method of claim 11, wherein forming the undoped semiconductor layer in the upper part of each deep trench comprises:

forming an undoped semiconductor material layer on the substrate to fill the trenches and to cover the first mask layer; and

performing a partial removing step to remove the undoped semiconductor material layer that covers the first mask layer and a portion of the undoped semiconductor material layer in the deep trenches.

16. (original) The method of claim 15, wherein the step of performing the partial removing step further comprises:

performing a chemical mechanical process to remove the undoped semiconductor material layer the covers the first mask layer; and

performing an etching-back process to remove the portion of the undoped semiconductor material layer in the deep trenches.

17. (currently amended) A fabrication method for an electrode of a deep trench capacitor, the method comprising:

providing a substrate;

forming a plurality of deep trenches in the substrate, and the deep trenches arranging into a plurality of columns, wherein between the deep trench and the neighboring deep trench that are at a greater distance apart on a same column is an active region, and a border of each deep trench that is adjacent to the active region is a first region;

forming a first conductive layer in a lower part and a middle part of each deep trench;

forming an undoped semiconductor material layer in ~~the first region at~~ an upper part of each deep trench; ~~and~~

forming a mask layer on the undoped semiconductor material layer;

performing an ion implantation process to implant dopants into the undoped semiconductor material layer outside of the first region to form a second conductive layer and

an undoped semiconductor layer in the first region, wherein the first conductive layer and the second conductive layer serve as the electrode of the deep trench capacitor; and

removing the second mask layer to expose the undoped semiconductor material layer ~~forming a second conductive layer in the upper part of each deep trench outside the first region, wherein the first conductive layer and the second conductive layer serve as the electrode of the deep trench capacitor~~.

Claim 18 (cancelled)

19. (currently amended) The method of claim ~~18~~17, wherein forming the undoped semiconductor material layer in the upper part of each deep trench further comprises:

forming a material layer on the substrate, filling the deep trenches and covering the substrate; and

performing a partial removal process to remove the material layer the covers the substrate and the portion of the material layer in the deep trenches.

20. (original) The method of claim 19, wherein the partial removal process further comprises:

performing a chemical mechanical process to remove the material layer that covers the substrate; and

performing an etching-back process to remove the portion of the material layer in the deep trenches.